the
CANNON
University of Toronto Engineering Society

NUCLEAR ISSUE

September 21, 1978

THE CANDU ACHIEVEMENT

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Corporate Vice-President, Engineering
Atomic Energy of Canada Ltd.

Last year, nuclear power contributed 27 per cent of electrical generation in Ontario, and seven per cent of overall Canadian electrical generation. The nine operating CANDU (CANada Deuterium Uranium) nuclear power reactors—all in Ontario—had an installed capacity of just over 4500 megawatts.

Nuclear power is an established fact in Canada. It has produced over 100 billion kilowatt-hours of electricity—as much as would provide the city of Ottawa with all its electrical needs, at present comsumption rates, for over 30 years.

By 1985, there will be an additional eight nuclear units in Ontario with an additional capacity of 5000 megawatts, plus power plants in Quebec and New Brunswick representing 1200 megawatts, for a total national capacity of around 11,000 megawatts. Assuming these new units are working at similar capacities to the present, they will produce ten per cent of Canada's electric power output.

More than fifty countries are pursuing a commitment to nuclear energy. At the end of 1977, 206 plants were in operation. These plants had accumulated more than 1500 reactor years of operating experience without a single radiation-induced fatality or even serious radiation-induced acident. Like their safety record, the commercial record of the present generation of nuclear power plants continues to be good. In all major industrial countries with nuclear power plants, such plants are generating electricity at total costs which are competitive with or considerably lower than fossil-fired plants of similar size.

Canada, with about four per cent of the world's nuclear capacity, is just about keeping up with other developed countries. France has presently about 5,500 megawatts of nuclear capacity in operation, Britain about 7,000, in each case generating around 10 per cent o generating about 10 per cent of the national electricity supply. The United States has 70 nuclear power stations with operating licenses, with 50,000 megawatts capacity or 9 per cent of total U.S. installed electric generating capacity. Present commitments indicate that by 1985 the total capacities of Britain, France, and the U.S. will be 13, 43, and 153 gigawatts, supplying 16, 55, and 20 per cent of these countries' electricity needs respectively. This year, Japan's nuclear capacity becomes the second in the world as it rises above the 10,000 megawatt level by the year's end. The Japanese government-controlled Electric Power Development Company (EPDC) is actively considering the importation of CANDU reactors from Canada as part of the national nuclear electricity program.

The evolution of the CANDU system goes back to the mid 1950s. When the first studies of commercial power Reactors were undertaken by AECL, Canada had already accumulated construction and operating experience on heavy water moderated, natural uranium fuelled experimental reactors at Chalk River, begun as a research establishment during the final months of World War II.

The United States had already developed a design using enriched uranium, which evolved from nuclear submarine propulsion units devised for the U.S. Navy. Great Britain and France had gas-cooled graphite-moderated units which evolved from plutonium production reactors for their weapons programs.

Canada had neither a weapons program nor access to enriched uranium.

A heavy water moderated, natural uranium fuelled reactor was therefore a logical choice. To sustain a fission reaction with natural uranium, the key was neutron economy—to minimize the loss or absorption of neutrons in reactor components other than the uranium fuel. The metal zirconium has a very low tendency to absorb neutron—that is, a low neutron capture cross section. The development of a new zirconium tubing allow, Zircaloy-2, during the design period of NPD made it practicable to use a pressure tube design for Canada's first prototype Nuclear Power Demonstration(NPD) reactor. In this design both fuel and coolant were held in a Zircaloy pressure tube. Access via the end fittings of these pressure tubes by a specially designed automated and pressurized fuelling machine meant that fuel could be replaced while the reactor was in operation, thus enabling such a nuclear station to run continuously without shutdowns for refuelling.

The NPD reactor was put into operation in 1962, and its early runs were encouraging enough so that a prototype reactor, the 200 MW(e) Douglas Point Station, was committed, and completed in 1967. Scale up to commercial size revealed a number of problems, such as heavy water leakage and short pump seal life. While these problems affected the performance of the prototype station, the experience contributed to the remarkably smooth commissioning of Canada's first commercial nuclear generating station—the four units of Pickering Nuclear Generating Station "A" were placed in-service between July 1971 and June 1973. Each unit is of 515 MW(e) capacity.

The lifetime net capacity factor(NCF) of Pickering, excluding a four month strike period in 1972, has been 80 per cent, to February 28, 1978, over 22 unit-years of experience. Because of their low fuelling cost these units are run as base load generation, and shut down only for maintenance or replacement of equipment. Unit reliability is particularly important during the peak load months from December through February. Last winter, net capacity of the station was 99.8 per cent—an almost perfect performance.

In 1977 the pickering units ranked first, third, fourth and sixth in the world performance ratings for all nuclear units larger than 500 MW. The ranking is based on gross capacity factor, the ration between the total electric energy produced by the unit and perfect output.

The major achievement of the Pickering station, in addition to its high availability, has been its low fuelling cost, which has varied from 0.91 mills per kilowatt hour in 1977. This is half that of any other North

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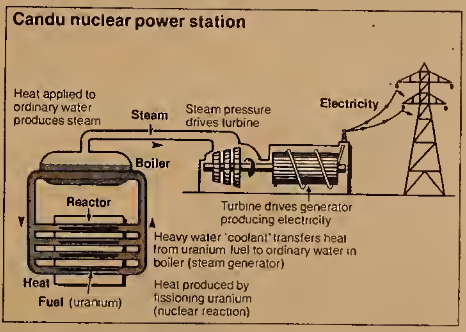

UNCLEAR ABOUT NUCLEAR?

By William C. Bowman

For many Canadians, nuclear engineering is a poorly understood discipline. This article will describe the types of work available in the nuclear industry to those considering a career in this field. Since few formal nuclear engineering departments exist in Canadian universities, the information presented here should help students enrolled in other applied science departments to shape their curricula to provide the background required by a nuclear engineer.

As with all engineering, nuclear engineering deals with the practical application of the pure sciences. Nuclear and atomic phenomena are controlled in various ways to provide useful tools for the service of mankind. Some examples are the production of thermal and electrical power, treatment of disease and measurement of plant process variables. Nuclear engineers are needed to design equipment for controlling nuclear processes. Special safety requirements arising from the characteristics of these processes must be considered. Operation goes hand in hand with the design of nuclear equipment, and thus nuclear engineering expertise is necessary to maintain safe, reliable service from operating machinery and instrumentation. An understanding of nuclear/atomic radiation, nuclear reactor physics, radiation shielding and nuclear instrumentation, combined with the basic engineering fundamentals provide the nuclear engineer with the essentials for the design and operation of nuclear installations.

Of all the industries utilizing nuclear processes, the business of electrical power production is by far the most capital intensive. Reactor vendors and utilities operating nuclear power stations are therefore the largest employers of nuclear engineers. Some of the jobs to be expected from the companies operating nuclear

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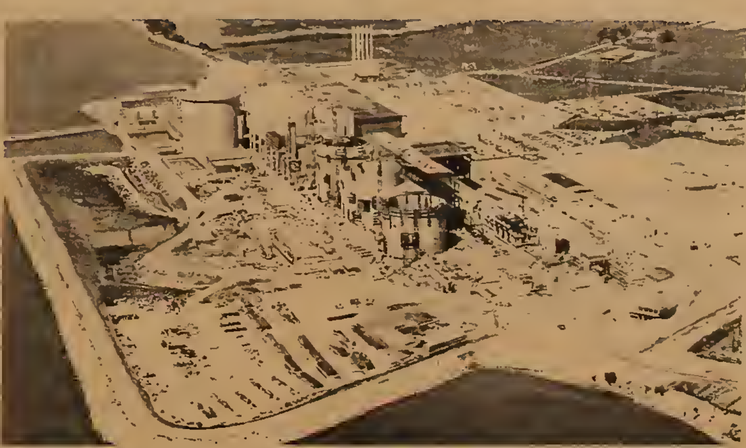

Pickering Nuclear Generating Station

The CANDU Achievement

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American nuclear generating station, and compares with 15.5 mills per kWh for Lambton, a similar sized Ontario Hydro coal-burning station.

Of course, in evaluating economic efficiency, the Total Unit Energy Cost (TUEC) must be considered rather than fuel cost alone. On this basis, on kWh from Pickering costs 5.38 mills for capital expenses, 2.07 mills for operation and maintenance, and 0.52 mills for heavy water upkeep, which with fuel costs, brings TUEC to 9.10 mills per kWh—still substantially less than fuelling costs alone for Lambton. It is estimated that Pickering, since going into service, has saved the people of Ontario about 1,200 million dollars worth of imported coal, based on the current replacement cost of coal. This saving has more than paid for the station's capital cost of 753 million dollars.

It should also be noted that this record has been achieved with remarkably low emissions of radioactivity. Even though designed before Ontario Hydro and AECL agreed upon an operating target of one per cent of Atomic Energy Control Board license limits for air and water emissions of radioactive substances, average emissions to air and water have ranged (depending on the radiochemical substance specified) from 0.01 per cent to 0.27 per cent of licensed limits.

Three units of Ontario Hydro's second nuclear generating station Bruce have been put in service. These are a larger type, each producing 740 MW (net) of electric power. While the initial operating stage of these units is too early to have built up the formidable record of Pickering, Ontario Hydro is confident that the same high reliability and low costs will be achieved. Each unit has the additional capability of supplying up to 318 MW of thermal energy to Ontario Hydro's heavy water production plants at Bruce, the largest heavy water production complex in the world. The demonstrated capacity of these heavy water plants has exceeded design capacity of 96.6 kg/hr, by about ten per cent. The plant produced 655 tons of heavy water in 1977.

Ontario is continuing its program of four-reactor generating station, at Pickering "B," Bruce "B," and Darlington which will more than double Ontario Hydro's nuclear capacity by the late 80's. Engineering studies are being carried out for a 1250 MW(e) unit which, if adopted by Ontario Hydro, would also be built in a four unit station. It is estimated that by the end of the century there will be about 100 nuclear electric generating units across Canada, with a total capacity of about 80,000 MW(e)—equivalent to Canada's total electric generation capacity at present.

Continued next issue

TABLE 1

Countries with installed nuclear generating capacities over 1000 MW[e]

U.S.A.	50,431 Net MW[e]
Japan	8,548 "
Germany [Federal Republic]	7,950 "
U.S.S.R.	7,900 "
U.K.	7,016 "
France	5,590 "
Canada	4,793 "
Sweden	3,730 "
Belgium	1,667 "
Italy	1,412 "
Germany [Democratic Republic]	1,400 "
Spain	1,120 "
Switzerland	1,006 "

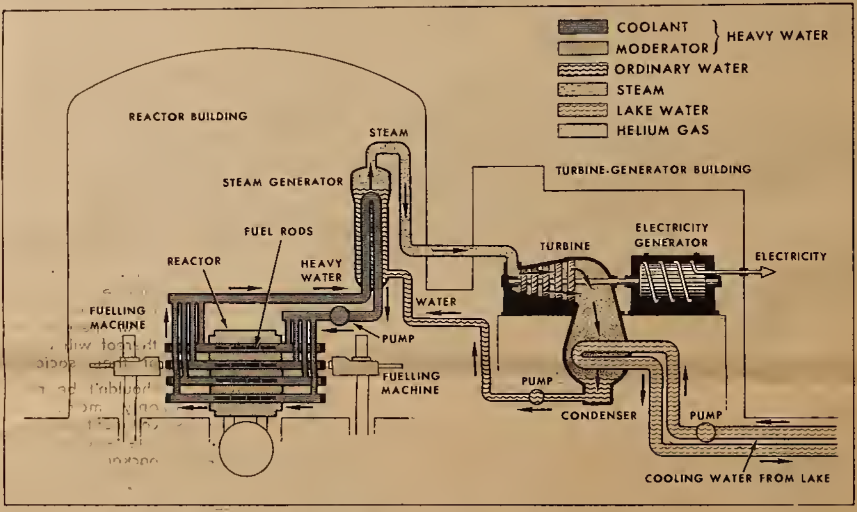
Source: Atomic Industrial Forum
June 30, 1978

TABLE 2

PICKERING NET CAPACITY FACTORS — 1973-1977

	1973	1974	1975	1976	1977
Unit 1	92.5	72.0	80.2	92.8	85.5
Unit 2	69.0	88.4	86.0	93.2	90.9
Unit 3	85.1	42.7	57.5	93.9	95.6
Unit 4	90.1*	93.9	23.8	68.4	90.8
Average	83.4	74.3	61.9	87.1	90.7

* This figure is for the 6-1/2 months after the station's in-service date of June 17, 1973.



The CANDU-PHW system (Canada Deuterium Uranium-Pressurized Heavy Water) is used in Douglas Point, Pickering and Bruce nuclear power stations. Heavy water moderator surrounds the pressure tubes containing the fuel elements. Heavy water under high pressure is also used to transfer the heat from the fuel to ordinary water in the steam generator. This turns the ordinary water to steam which is fed to the turbine.

TABLE 3

1977 WORLD POWER REACTOR PERFORMANCE

Unit	Country	Type of Reactor	Gross Capacity MW	Gross Capacity Factor%
Pickering 3	Canada	CANDU	540	95.7
Stade 1	W.Germany	PWR	662	93.6
Pickering 4	Canada	CANDU	540	91.1
Pickering 2	Canada	CANDU	540	91.1
Prairie Island 2	USA	PWR	547	86.2
Pickering 1	Canada.	CANDU	540	85.8
Palisades	USA	PWR	722	85.4
Point Beach 1	USA	PWR	524	84.1
Genkai 1	Japan	PWR	559	84.0
Millstone 1	USA	BWR	690	83.4

TABLE 4

TOTAL UNIT ENERGY COST COMPARISON

	Pickering	Lambton
Capital	5.4	1.8
Operations and Maintenance	2.1	1.1
Heavy Water Upkeep	0.5	-
Fuelling	1.1	15.5
Total UEC:	9.1$mkWh	18.4$mkWh

TABLE 5

Average radioacitivity emissions from Pickering 1974-1977

Emissions to Air	% of limit
Tritium	0.27
Iodine-131	0.01
Particulates	0.03
Noble Gasses	0.18
Emissions to Water	
Tritium	0.07
Gross beta-gamma	0.14

LETTERS

Dear Sir:

Please accept my best wishes and my full support for "The Cannon" in working towards the goals you have set for yourself. I understand that your aim is to produce a serious publication devoted to educational, scientific, technical and professional matters of concern to Engineering students. I have no doubt that there is an enormous potential both for contributors and readers of a good publication of this kind. I hope you are successful in tapping it! The projects and theses of undergraduate and graduate students by themselves constitute an enormously rich source of material for your publication, and I hope you will succeed in getting contributions from that source as well as from others. I look forward with anticipation to the appearance of your first issue, and wish you every success.

Sincerely yours,

B. Etkin

Dean

EL PRESIDENTE SPEAKS

Hello and welcome to your new Engineering newspaper, The Cannon.

The Cannon replaces the "Tiny Toike" concept as our medium for internal communication of meetings and events. The Cannon is also a new medium; a technical and news forum. The Cannon is intended to provide articles of technical interest to all Engineering disciplines and news from the Engineering Society, the Faculty, SAC, and the University. We are looking to you, with your variety of background and experience, to give The Cannon its material, as well as to the Faculty, the Alumni and the business community. Your fourth year theses will be an excellent source, as well as your "at-home" technical hobbies, your work experience and hopefully, the Cockburn Centre.

Let's get one thing straight: The Cannon is not intended as a pacifier for opponents of the Toike. It is not here to replace the Toike. The two are entirely compatible; in fact, the excellence of one could only diminish with the loss of the other. We all have a lighter side. "There's a time for work, and a time for play." The Toike should strive to appeal to a wide cross-section of people on the basis of its humor and its "joie de vivre." This has been its role, although it has not always succeeded and it should remain (or become) our court jester, purveyor of the essential spirit.

But, there are those that can do without humour and those that can do without academics. Both are a minority, in fact one is hard-pressed to think of anyone in either category. Most of us are a "shade of grey"; somewhere in a position between the two extremes. Assuming a continuous distribution of personality and a probability of finding one person at the absolute limit either way of zero, one can easily see that we all can derive a finite benefit from both.

Hypothesizing and mathematically proving the existence of benefit doth not a paper make. Both mediums need intelligent, well thought-out creataive input. That's also what Engineering is all about, isn't it?

The "Engineering Press" has expanded and is still expanding. You've already received this year's Handbook and Calendar, thanks to the faithful and creative efforts of the respective editors. The Eng.Soc. will soon be receiving a "computer-based" typesetting system to help facilitate production of (primarily) the Toike and The Cannon. Pending the fullfillment of the position: editor, we will again have a Yearbook, and for the first time since 1973, we are seriously attempting a Yearend Report.

We think maybe a good number of you aren't totally aware of the services offered by and the potential of the Society. Its not completely Council's fault (hint, hint) but we hope this is a step of the correct orientation.

I hope and firmly believe that the small, four-page-tab issue you are reading today is the germ of something much larger, in concept, size and distribution.

We are living today in a technological society. But man's general knowledge of the technical concepts involved in many common iters (buildings, calculators, cars, clothing, paper, medical equipment, etc.) lags far behind the prevalence of those items in society. Indeed it appears that as a high-technology item becomes readily available to the householder, the householder understands less and less about it. (The prime example is of course, the calculator — but let's not forget microwave ovens and cameras.) Society tends to accept technology readily, blindly, unless it cuts into their backyards, or it becomes a threat to their fertility. Acceptance of anything until it goes wrong is a general trait in mankind, including Engineers. Engineers are adjusting themselves, but society as a whole hasn't yet. Society must be aware of its technology. Think of medicine. One knows that if one kneels over in the middle of the street, one will be picked up within five minutes and zoomed off to a clean, sterile hospital and will wake up, safe, albeit uncomfortable, with a couple of bottles hanging beside the bed and tubes in one's arms, several hours later. Society accepts and is not confused or bewildered by medicine. The concepts are easy to understand and are well-known. (The technology used by the medical profession is another story.) But not all citizens are doctors. In fact, there is a fairly constant shortage of doctors, due to intelligent regulation by the Medical Association. Man has been educated to understand and accept modern medicine. This has been accomplished directly, through the elementary and secondary school system.

As Engineers, we know that the basic Engineering concepts are easy to understand and they're certainly well-known to us. But what of the rest of society? Unless one is taking sciences or Engineering at University, one probably didn't even take Calculus or Physics in Grade 13. Calculus and physics aren't as basic as one could get, but at the high shcool level, that's currently it for Engineering.

So what is the answer? As usual, for Engineering questions, there is no single answer. Generally, of course it's education. Should more people become Engineers, in order to "spread the word?" The Medical Association by analogy clearly indicates: "no." Should everyone be encouraged to take technology courses at one of the dozens of Community Colleges? These are primarily technicians' courses. It one gains insights by soldering one black box to another, and memorizing patterns, then it can't hurt, but that's not much to do with Engineering. How about putting all University students through several "technical" courses in APSC as requitement for any degree. That would certainly improve things, although it would be extremely difficult to set up. Perhaps it would be easier to insert the Engineering students into the general education stream for a few credits in order to at least encourage some understanding between technology and society. Perhaps all Engineering students should be required to be in a general program first, hence by inference, the Engineer would come from his society, rather than be placed into it to a greater extent and thus he/she could understand it and be in a better position to communicate with it. Perhaps high shcools should incorporate basic technology-oriented courses into their required curriculum.

All these and combinations thereof will produce operation of their society. Technology shouldn't be magic. One can only make an intelligent comment on something when one knows the issues and background involved.

What has this to do with The Cannon? It's part of the solution, or it can be. The Cannon should grow to a size that can accommodate the hundreds of developments taking place every day. It should eventually increase its circulation, to serve the entire University community to the end of educating the rest of the "higher-education" people to some of the principles of Engineering. The Cannon is the beginning of the answer. Presenting technical subjects in a newspaper format on a level of interest to all Engineering disciplines should also lend itself to appealing to anyone with the very slightest of technical background.

Engineers and technology need to be integrated into society. Education of more people in technology and the general aspects of Engineering should elevate the Engineering profession to the stature it deserves. Engineering is far too often down-graded by mistrust and misinterpretation of Engineering work, by laymen who know little or nothing of the technical aspects of the issues at hand. If society were educated in the general principles, as they are in medicine, many heartaches and debates can be avoided as well as Toffler's "Future Shock."

To start with, let's educate each other. The Cannon is only a first step, as I see it. Down the road ... who can guess?

I seem to have forgotten something ... Welcome or welcome back to Skule. We have a lot of great things planned. Come out to Society meetings, come and visit me. Life is too short, and it's so much fun; Best of luck, have a good year.

Rob Yates 7T9
President of the Engineering Society

UNCLEAR ABOUT NUCLEAR?

cont. from pg. 1

power plants will be described here:

PLANT OPERATIONS

The tasks performed here are too numerous to describe in detail, but in general the work involves instigating and planning procedures and schedules for the operation and maintainance of power plant equipment. Nuclear engineers are required to solve the day to day problems arising in the operation of nuclear systems. Special features and safety requirements particular to the nuclear part of the station must be considered. Reactor physics calculations play an important role in nuclear reactor operation. Fueling strategies must be designed to provide maximum utilization of the uranium consumed in the fission process. Radiation shielding calculations and designs are required when work is to be performed in particularly "hot" areas of the plant. In addition to nuclear process systems, all nuclear generating facilities have a conventional side also. Engineers will encounter many projects in this area, providing experience which will be beneficial if a better opportunity arises outside the nuclear field.

In addition to the actual operation of generating stations, most utilities employ a service staff to troubleshoot difficult problems and supply computational services for specifying proposed changes in procedure. This leads to another area of employment for the nuclear engineer.

SIMULATION AND SAFETY ANALYSIS

Nuclear regulatory bodies require that vendors and operators of nuclear power plants be able to predict, with reasonable confidence, the behaviour of their power plants. Engineers working in plant operations are very capable of predicting system behaviour under normal conditions, however, the outcomes of accident, or otherwise abnormal conditions, are open to a certain amount of speculation. Mathematical and computer models of the power station components are required to simulate upset conditions. Verification is achieved by simulating planned tests and comparing the prediction with actual data from the plant. Nuclear engineers are needed for model development. Unlike the design calculations made in building the power plant, the results of accident simulations can probably never be verified. To a certain extent the calculations depend upon the intuition of the engineer, necessitating a good "feel" for the behaviour of nuclear systems.

Computer simulation is becoming increasingly important in design, as well as operation of nuclear power stations. Tolerances (and thus cost) can be reduced if the multi-component interacting systems can be simulated. Those interested in mathematics and numerical analysis should consider this area of nuclear engineering.

It is hoped that this description of possible jobs will be helpful to those considering the nuclear field. Although vendors and operators of nuclear generating stations are the largest employers of nuclear engineers, consider all industries using nuclear processes as prospective employers. Pursue the job that is most compatable with your interests.

the CANNON

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Associate Editors: Dona Williams, Rob Pupulin, Peter Ronkin

Press: Eric Hosking, Rob Yates

the CANNON is supported by the Engineering Society. It is run by the students in the faculty of Engineering with the intent of providing the students in Engineering with an interesting and informative newspaper. All those who would like to help with your paper are welcome to. Submissions to the CANNON are also welcomed. They should be typed. The editors reserve the right to edit letters. The office of the CANNON is located on the Third Floor, Old metro Library, 20 St. George ST., Toronto, Ontario, M5S 2E4.

THE ENGINEERING SOCIETY YEARBOOK

Here is a list of those helping with the yearbook so far...
wouldn't you like to be a part of what appears to be one of your major concerns?

Last Year's Yearbook Editor, Sneaky Pete

UP AND COMING EVENTS

"you never knows unless you tries"

check the bulletin boards for full listings of SAC sponsored events

INTRAMURAL HOCKEY

Any class interested in entering a team should obtain a form from the athletic stores and place the completed form in the hockey box in the engineering stores. All teams must have a goalie and manager. Any problems, call Ray Gibson, 444;0739.

SHINERAMA T-SHIRTS

$2.00 will buy you one of these babies.

Contact Poco at the engineering stores.

SEPT. 21	Introductory Employment Seminar (4th Yr.)
SEPT. 22	Mechanical Engineers G8120 12-1PM Introductory Employment Seminar (4th Yr.) Chemical Engineers W8130 10-11 AM Last day to add or substitute fall term or full year courses.
SEPT. 25-OCT. 4	4th Year Grad Photos -sign up for a time in the Engineering Stores
SEPT. 26	Women's Wine and Cheese Party
SEPT. 27	Eng. Soc. Exec. Meeting Hart House South Dining Room 5PM
SEPT. 28	Installation of President Ham, former Dean of Engineering. Convocation Hall
SEPT. 30	SHINERAMA — Shine Shoes for Cystic Fibrosis
OCT. 5	Resume and Interview Preparation Seminar For Engineers SS2135 5-7PM

TORONTO: PUBLIC TRANSIT ORIENTED CITY

By Robert Pupulin

Toronto continues to lead all major Canadian cities in the public transit field; subway service commenced here in 1954, beating the Metro in Montreal by more than a decade and Edmonton's system by 24 years. Today, officials from other public transit services study the Toronto Transit Commission's set-up in hopes of applying the TTC principles to their own transit services.

There exists a number of reasons for the transit system's success; Toronto's lack of a complex expressway system, relatively low cost for commuters, a deficiency of hassle-free parking in and near downtown, a high core density, a relatively low crime rate, relatively narrow downtown streets, the influence of the subway lines on high -rise, therefore, high-density developments and a modified attitude on the part of the transit authority are the principle ones.

Toronto does not possess a terribly intricate network of radial and circumferencial expressways which would allow for rapid travel of an automobile from any one point in the city to any other point in the city. It is much easier, rather, to "TTC" within the city and eliminate the battles and frustration with traffic, parking problems, and road construction. An example of a North American city with a decent expressway system and a very poor public transit one would be the motor city, Detroit. There, auto travel is greatly facilitated within the city via the maze of expressways.

The cost of gasoline consumed plus parking during a week of commuting to and from the suburbs to downtown will be greater than the cost of one week's TTC fare; commuters find it much cheaper to ride the TTC.

Parking lots in the city are numerous however, the number of headaches encountered in the quest for a "good" lot may be high. A good lot is one that is convenient, very cheap, free from vandalism, and where entry, re-entry and exit from are easy. Transit users have no such problems.

The relatively low crime rate in Toronto does not induce fear in the hearts of urban dwellers as does the high rate of crime in Detroit. Even if Detroit had a modern public transit system comprised of rail vehicles, one would have to be crazy to use it.

The main streets in auto-oriented cities may be about twice the width as their counterparts in Toronto. Yonge Street is only 2 lanes wide "per direction" and can be reduced in width by a motorist turning left or a stopped delivery van. To avoid the slow moving traffic due to a congested street, one has simply to hop on the subway.

High density residential and commercial areas sprouted up around the Yonge Street subway stations after inauguration of service on that line. The same type of development occurred during or just after construction of the east-west line and again *before* construction of the east-west extension. The TTC, in this case, unknowingly gave rise to or aided new developments which in turn benefitted the TTC since people in those locations would have obviously used the new public transit.

The Toronto Transit Commission today considers itself a service rather than a business. The business frame of reference looks only at profit-minded ventures; the TTC, before receiving Ontario government subsidies, would delete a non-profitable route. Now, funds received from sources other than transit users are, as the TTC states, "a payment by the community for services rendered" since the transit organization helps preserve the environment, save energy and promotes good use of land.

The fact that Toronto is indeed a public transit oriented city can be verified by observation of the city during the recent transit strike. Cars were parked everywhere causing police to alter parking regulations temporarily. Traffic was heavier than usual even during non-rush hour periods. It was reported on a local radio station that commercial establishments experienced a drop in business during the strike. Toronto seems to be designed for public transportation and really can't function properly without it.

THE BLUES HOME OPENER against Laurier takes place this Saturday at 2:00 PM in Varsity Stadium. Student Admission is $1.50 per game, a Season Ticket will get you in to all three home games for the price of only $3.00.

DIVERSIONS

By Bramer Kgnart

Faced with another dull lecture? Copying notes verbatim from the board and having that feeling that the Prof. copied them verbatim from the textbook? Maybe you would like to do something equally as constructive and yet a little bit more entertaining. Try this diversion to fill up those long hours of unmitigated boredom (or try ignoring it. Either way use it to occupy yourself).

Life is a game made popular by Martin Gardiner author of the Mathematical Games department in Scientific American. For the uninitiated, Life is played on a 2-D matrix whose elements are either beings or empty spaces. At the outset of the game, beings have to be placed on the matrix by the player with the intention of having the beings exist as a colony. Thereafter, the beings live, reproduce, and die according to these rules:

1) Beings die from: i. Overpopulation—4 or more neighbours on the 8 adjacent matrix elements. ii. Isolation—1 or no beings in the adjacent elements.

2) Beings are born when an empty element is surrounded by exactly three neighbours.

3) All other beings continue into the next generation.

Interesting patterns emerge grow and die in the course of the existance of the colony and it is useful to have several matrices around to record the development that goes on. It is also necessary to have at least two matrices so that the present generation can be built based on the last one.

To make the game more interesting it is possible to have more than one colony competing for the same space. Even better, you can add a being to a strategic position every generation to either strengthen your own position or weaken the opposition. Rules governing birth and death at the interface of colonies have to be developed and agreed upon according to personal taste.

One drawback to this diversion is that it tends to get boring writing out every generation when the number of beings is large. However, the really bored (of lectures that is) candidate can take the effort to write a simple program that will let the computer do all the figuring and drawing. This should cure your boredom in the lecture room because you're going to spend twice as much time in the computer room.

4 generations: